MARS EXOBIOLOGY LANDING SITES FOR FUTURE EXPLORATION;

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Summary

The selection of landing sites for Exobiology is an important issue for planning for future Mars missions. This report presents results of a recent site selection study which focused on potential landing sites described in the Mars Landing Site Catalog [1]. In addition, we will review basic Exobiology science objectives in Mars exploration, and outline the procedures used in site evaluation and prioritization.

Discussion

The selection of landing sites is based on the assumption that liquid water is a fundamental requirement for life. This is consistent with the assumed importance of a hydrologic cycle in allowing for the development and diversification of life [2]. Geological evidence for abundant water on Mars early in its history is substantial [3]. Depositional environments considered of primary interest include: fluvial-lacustrine, thermal spring, and periglacial. Of these, fluvial-lacustrine sites are considered to be excellent targets for meeting the goals of Exobiology, because 1) fine-grained water-lain sedimentary deposits are good host sediments for fossils and/or organic compounds, and 2) large lacustrine basins that have not received a younger volcanic cover make good landing targets from an engineering standpoint. Potential sites for hydrothermal activity were identified by simple "point source" channels with amphitheater headlands that occurred in close proximity to volcanic areas. Ground-ice may hold the largest reservoir of water on Mars [3]. Frozen soils in periglacial environments are of great interest to Exobiology, because ground-ice may contain a climate record of the past and it may have served to inhibit diffusion of oxidants in the soil, thus favoring preservation of organisms and organic compounds.

The first stage of the evaluation utilized the Viking Mars Chart (MC) prints (scale 1:2M) and the Mars Transverse Mercator (MTM) maps (scale 1:500,000). The subsequent phase applied Viking Orbiter (VO) images to selected sites of relatively high criteria scores from the previous analysis. Based on the latter evaluation, 17 sites were analyzed using the best (~250 m/pixel) resolution Viking Orbiter images obtained from the Image Retrieval and Processing System (IRPS). The final phase consisted of retrieval of Mosaicked Digital Image Models (MDIM's; resolution 231 m/pixel) of the respective sites. Features (landforms and deposits) used to identify each site type were assigned scores based on three subjective weighting factors, including visibility of feature on the image, uniqueness of the feature-process relationship, and importance of the features in relationship to goals of Exobiology.

Of the 83 sites listed in the Mars Landing Site Catalog [1], 13 were assigned a high priority for Exobiology by the methods outlined above. In addition, 5 additional sites not listed in the Mars Landing Site Catalog were identified and proposed as additions to the next edition of the catalog (Table 1).

Two sites that were assigned high priority for Exobiology were also identified by the MESUR Science Definition Team as favorable landing sites for the proposed Pathfinder mission [4]. The sites (Gusev crater: 15 deg S, 185 deg W [5] and Mangala Valles: 6 deg S, 149.5 deg W) are characterized by flat terrain and fine-grained sedimentary cover which meet important engineering constraints for safe landing sites. This illustrates the congruent nature of the criteria used to define high priority sites for Exobiology and other disciplines concerned with landing site identification.

The Gusev crater consists of an ancient 135 km diameter impact crater, filled with sediments derived from an 800 km long channel cut into cratered uplands. The floor of

the crater varies from hummocky crater ejecta to relatively smooth floor at the resolution of available images (50 m/pixel). The Mangala Valles site is on the floor of a 50 km diameter impact crater that has received sediments from channels originating from surrounding highlands. It has a well-developed delta at the mouth of a channel emptying into the crater. Albedo patterns on the floor suggest the presence of sediments reworked by the wind.

In summary, this study identifies a preliminary site list for Mars exploration Exobiology and outlines a conceptual framework for the objective evaluation and prioritization of sites to meet Exobiology science objectives. Exobiology shares important goals in Mars site selection with other planetary science disciplines, illustrating the advantage of a multidisciplinary approach in developing site selection strategies for future Mars missions.

References Cited

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3. Squyres, S.W., Urey Prize Lecture: Water on Mars, *Icarus 79*, 279-288, 1989.
4. MESUR Science Definition Team, *Proceedings of Sixth Meeting*, Oct. 1992.
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POTENTIAL MARS EXOBIOLOGY SITES FOR FUTURE EXPLORATION

LSC site no.	Location of interest area (lat., long.)	Target (lat., long.)	Name of general site area	Relative level of priority	Suggested refr.	Total score (V.O. img.)
1	35°-38°S, 227°-231°W	37°S, 230°W	Eridania NW	High	MC-29NW	72
2	21°-23°S, 9°-14°W	22°S, 11°W	Margaritifer Sinus SE	High	MC-19SE	66
8	22°-23.5°S, 229°-231°W	22.8°S, 230.6°W	Mare Tyrrhenum SE	High	MC-22SE	72
10	24.5°-26.5°S, 264°-266.5°W	24.8°S, 265.8°W	Mare Tyrrhenum SW	High	MC-22SW	72
137	5.6°-6.4°S, 149.1°-149.9°W	6.3°S, 149.5°W	Mangala Valles	High	MTM -05147	54
79	13.5°-15.5°S, 187°-190°W	15.5°S, 188.5°W	Aeolis SE	High	MC-23NE,SE	56
138	13.5°-15.5°S, 183.5°-185.5°W	15.5°S, 184.5°W	Aeolis NE (Gusev)	High	MC-23NE,SE	61
140	6.5°-9°S, 302°-305.5°W	7.3°S, 305°W	Iapygia NW	High	MC-21NW	72
5	10°-11.5°S, 277°-280°W	11°S, 279.5°W	Iapygia NE	Moderate	MC-21NE	75
7	41.5°-43.5°S, 208°-212°W	43.2°S, 208.1°W	Eridania NC	Moderate	MC-29NC	66
22	5.9°-6.2°S, 73.7°-74°W	6.05°S, 73.75°W	Candor Mensa	Moderate	MTM -05072	18
32	33°-35°S, 264°-268°W	33.2°S, 266.4°W	Dao Vallis/Hadriaca Patera	Moderate	MC-28NE	18
4	55°-58°S, 190°-199°W	57°S, 197°W	Eridania SE	Low	MC-29SE	30
21	17.9°-19.2°N, 59.2°-53.8°W	18.95°N, 53.5°W	Maja Valles/ Chryse Planitia	Low	MTM 20052	68
26	17.7°-18.2°N, 55.5°-56.1°W	18.05°N, 55.7°W	Maja Valles	Low	MTM 20057	48
77	2°-4.5°N, 15.2°-17°W	2°N, 16°W	Ares Vallis	Low	MC-11SE	49
139	22°-23.5°N, 34.5°-36.5°W	22.1°N, 36.7°W	Oxia Palus NW	Low	MC-11NW	12
141	0°-2°S, 73.5°-78°W	1.5°S, 76.5°W	Hebes Chasma	Low	MC-18NW	21

Note: Sites 137-141 will be included in the next edition of the Mars Landing Site Catalog

Table 1